(2) Observatory of Potsdam of which Dr. Sprung is director, including two sections; (*a*) meteorology and terrestrial magnetism; (3) 202 stations, of which 148 are in Prussia (123 first and second order, 71 third, and 8 fourth order).

In the course of the year 1899 the number of rainfall stations was increased by 70. January 1, 1900, it was raised to 2,315, including the 202 meteorological stations just mentioned. The study of atmospheric precipitation is of great practical importance; it interests agriculture as well as industry; now that the rivers have again become very important mediums of transportation and that they are the sources of energy, it is of the utmost importance to be acquainted with their regimen and their sources of supply.

In this same train of thought the Meteorological Institute of Prussia carried on in December, 1899, observations of the depth of snow on the ground and its equivalent in water, and established a service of forecasts bearing on this subject. Thus, December 19, it was able to send to the hydrographic services of the five great rivers of Germany dispatches indicating the depth of the snow in the five basins, observed the day before at 7 a.m. The geographers and the meteorologists can refer for details to the weekly reports as to the depth of snow on ground in north Germany.

The annual report of the Royal Meteorological Institute of Prussia contains the list of the publications issued either by this scientific establishment or by its colaborers.

## TEMPERATURE OF DEEP LAKES.

In the MONTHLY WEATHER REVIEW for 1898, page 167, we have mentioned the thermophone devised by H. C. Warren and G. C. Whipple, and first described by them in the Technology Quarterly, 1895, Vol. VIII, pages 25–152. A previous elaborate paper by Prof. W. R. Nichols was read in 1880 before the Boston Society of Natural History. Observations relating to Clear Lake, N. B., were made by Prof. W. F. Ganong of Smith College, Northampton, Mass., but those made by the inventors and Mr. Desmond Fitzgerald in Lake Cochituate were more elaborate and established the great value of this apparatus. Previous to that time the deep sea thermometers of Negretti and Zambra or Casella were the best available. H. B. de Saussure used in Switzerland an ordinary thermometer so protected that it could be hauled up a thousand feet without changing its temperature 1° centigrade. A series of observations by the older methods had been carried on for five years by Mr. Fitzgerald before the thermophone became available; the results of both series mutually confirm each other. A similar series was observed at Lake Winnepesaukee and several other lakes or reservoirs and the general results of both American and European observations are given in the paper by Fitzgerald published in the Transactions of the American Society of Civil Engineers, Vol. XXXIV, pages 67–114.

In general, Mr. Fitzgerald showed that there is an annual inversion of the vertical circulation in a fresh water pond, by reason of which when in winter time the lowest portions begin to cool below 39° Fahrenheit or 4° centigrade they rise because of their diminishing specific gravity and bring up the products of decaying vegetation.

In a shallow lake, such as the reservoir, this circulation produces an appreciable discoloration and contamination of the upper water at certain seasons; it is therefore a matter to be considered in connection with the supply of fresh drinking water for a city. On the other hand, the study of temperatures in very large natural lakes is a matter of scientific inquiry leading to important results in connection with the temperature of the air and the occurrence of fog, cloud, and rain, the melting of ice floes, to say nothing of the distribution of fish and marine plants; it may also have a bearing on other questions not yet fully appreciated. The most recent contribution to the subject is a study of the temperatures of Lake Ladoga, which is the largest and one of the deepest bodies of fresh water in Europe. The Editor would, however, suggest that possibly the lower portions of Lake Ladoga are salt water, just as in case of some lakes near Boston which apparently owe their origin to a glacial process similar to that which gave rise to Lake Ladoga. In the Paris Comptes Rendus for June, 1900, Lieut. Jules de Schokalsky of the Russian Navy, published a map of Lake Ladoga and the results of his own examination of its temperature for the years 1897–99. As similar investigations should undoubtedly be made on our great American lakes we reprint this article; evidently the thermophone will do the work more satisfactorily than the "upset thermometer."—ED.

## ICE CAVES.

On a preceding page we print a short account of the ice cave at Flagstaff, Ariz. There are many well-known cases in which glacial ice has been covered by earth to such a depth that it has been preserved for thousands of years, and the caves or wells penetrating therein preserve a temperature of 32° throughout the year. These, however, represent a very different phenomenon from that reported by Mrs. Renoe. In the ice cave at Flagstaff we have probably nothing to do with glacial ice; the ice is evidently formed annually within the cave and on the surfaces of its crevices. The ground around the caves can not have a temperature below that of freezing. The air temperatures at Flagstaff during December, January, and February frequently fall below freezing, and this wave of cold will penetrate many feet into the earth by the middle of summer, but this of itself would only give a low temperature in the ice caves and would not suffice to explain the formation of such masses of ice. It merely shows why the water percolating slowly into the caves must be of a low temperature. If there be a gentle circulation of the air going on, there must be a corresponding evaporation of a portion of this water, which will, of course, reduce the temperature still lower. Now, the dryness of the air at Flagstaff is often such that the temperature of the wet bulb thermometer is below freezing, and if there be a gentle circulation of such air within the cave, then ice may be formed.

Again, the entrance to the Flagstaff cave is at the bottom of a general depression in the ground; it must, therefore, receive the very cold air that settles into such hollows during clear nights; this air is cooled by contact with the surface of the ground, which latter is cooled by radiation to the clear sky. Even during the warm summer months the nocturnal radiation at this altitude (about 7,000 feet) is sufficient to produce temperatures below freezing, so that the water percolating through the soil into the cave may be frozen by contact with the cold air within the cave if the latter is slowly renewed every night.

The formation of ice in the cave near Flagstaff is undoubtedly not an isolated case and similar examples should be sought for and brought to the attention of the readers of the MONTHLY WEATHER REVIEW. Those interested in the subject would do well to test our suggested explanation by making accurate observations of the temperature and moisture of the air close to the surface of the ground at the time of the morning minimum temperatures, and especially during the summer months.

The Ice Trade Journal has from time to time published accounts of similar ice caves in various parts of the world. The February number states that about twelve miles from Ehrenbreitstein and a short distance from the Wallmerod